



The dermatoglyphic characteristics of transsexuals: is there evidence for an organizing effect of sex hormones

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Abstract

It has been proposed that gender identity and sexual orientation are influenced by the prenatal sex steroid milieu. Human dermatoglyphics and brain asymmetry have also been ascribed to prenatal hormone levels. This study investigated dermatoglyphics (total ridge count and finger ridge asymmetry) in 184 male-to-female transsexuals and 110 female-to-male transsexuals. In a subgroup, the relationship between dermatoglyphic asymmetry and spatial ability was tested. All investigations included controls. For all subjects hand preference and sexual orientation were noted. We hypothesized that the dermatoglyphics of male-to-female transsexuals would show similarities with control women and those of female-to-male transsexuals with control men. Our results showed a trend for a sex difference in total ridge count ($P < .1$) between genetic males and females, but no difference in directional asymmetry was found. Contrary to our expectations, the total ridge count and finger ridge asymmetry of transsexuals were similar to their genetic sex controls. Additionally, directional asymmetry was neither related to sexual orientation, nor to different aspects of spatial ability. In conclusion, we were unable to demonstrate that our chosen dermato-

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glyphic variables, total ridge count and finger ridge asymmetry are related to gender identity and sexual orientation in adult transsexuals. Hence, we found no support for a prenatal hormonal influence on these characteristics, at least insofar as dermatoglyphics may be regarded as a biological marker of organizing hormonal effects. © 2000 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Sex differences in cognitive functioning have been widely recognized. On the average men tend to excel at spatial (Voyer et al., 1995) and certain mathematical tasks (Feingold, 1988), whereas women excel at verbal (Halpern, 1992) and fine motor tasks (Hall and Kimura, 1995). These sex differences may result from psychosocial and/or biological factors (Halpern, 1992). Because brain asymmetry maybe affected by prenatal androgens (Geschwind and Galaburda, 1985), other somatic asymmetries may also reflect the influence of gonadal hormones. It was reported, for example, that women with larger left breasts and men with larger left testicles excelled at verbal tasks, whereas men and women with larger right sides did better on spatial tasks (Kimura, 1994).

Whereas the former study was based on self-reports, a more reliable approach of measuring somatic asymmetries is the study of dermatoglyphics, which makes use of the dermal ridges found on the fingertips, palms and soles of primates. The differentiation of finger ridges takes place in the fetus during the third and fourth months after conception (Holt, 1968). Ridge configurations are determined partly by genotype and partly by accidental or environmental influences during fetal life (Holt, 1968). It has been suggested that human dermatoglyphics are influenced by prenatal hormone levels (Jamison et al., 1993); higher testosterone levels in adult men were associated with a more pronounced dermatoglyphic asymmetry (Jamison et al., 1993). Finger ridge patterns are permanent throughout life, unless accidentally damaged and they vary in type across fingers and individuals. The Henry System of finger ridge counting (Holt, 1968) provides quantitative data for statistical analyses (see Fig. 1). Generally, in men dermal ridges lay further apart than in women (Holt, 1968). It has been shown that the mean total ridge count (TRC) is significantly higher in males (Holt, 1968; Kimura and Carson, 1995), while differences between races are limited to differences in frequency of the same pattern types (Grace, 1976; Ogunye and Sagay, 1981).

In order to measure dermatoglyphic asymmetry, finger ridge counts of both hands are compared. Although the majority of both sexes show a higher finger ridge count on the right hand than on the left, a higher percentage of left asymmetry ($L >$) was found in women than in men (Kimura and Carson, 1995). This directional asymmetry was associated with different patterns of performance on sexually dimorphic cognitive tasks: composite masculine tasks were performed better by subjects with a right asymmetry ($R >$), while composite feminine tasks

were performed better by subjects with $L > .$ Additionally, it was shown that more homosexual men had $L >$ counts than did heterosexual men (Hall and Kimura, 1994), while another study found that heterosexual men (both $R >$ and $L >$) and $R >$ homosexual men were more lateralized according to a dichotic listening task than were $L >$ homosexual men (Hall and Kimura, 1993). This suggests a relationship between somatic asymmetry, functional brain asymmetry and sexual orientation, which may have its origin in the hormonal environment of early prenatal life. As hypothesized for homosexuality, biological influences, such as sex hormones, may be involved in the origin of transsexuality. The size of the sexually dimorphic bed nucleus of the stria terminalis in the brains of male-to-female transsexuals has been reported to be smaller than those of control men and identical in size to control women (Zhou et al., 1995). Furthermore, sex differences in the performance of sexually dimorphic cognitive tasks seem to be less marked in transsexuals than in controls (Cohen-Kettenis et al., 1998). In line with these findings, we were interested to investigate whether male-to-female transsexuals (MFs), androphilic MFs in particular, would show more female-like dermatoglyphic counts and asymmetry than control heterosexual men (MCs). Vice versa, the question was raised whether female-to-male transsexuals (FMs), gynephilic FMs particularly, would show more male-like total ridge count and finger ridge asymmetry than control heterosexual women (FCs). Androphilics are defined as individuals with a sexual orientation towards men, while gynephilics are defined as individuals with a sexual orientation towards women. Androphilic MFs and gynephilic FMs are of particular of interest because these group are considered to be early onset transsexuals, more comparable with homosexual subjects than with heterosexuals. Because one previous study (Hall and Kimura, 1994) found a difference in finger ridge asymmetry between homosexual and heterosexual men, we also expected to find a similar difference between the androphilic MFs (i.e. genetic males with a sexual orientation towards men) and the heterosexual men. In addition, we aimed to

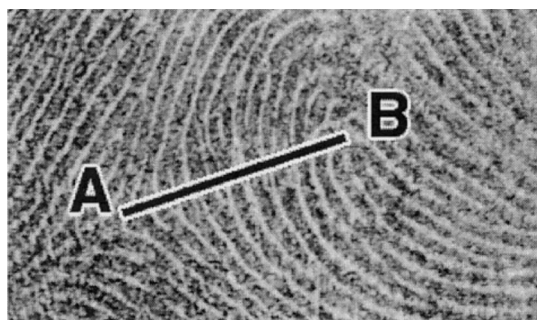


Fig. 1. Finger print of a female right thumb, which shows an ulnar loop and a line drawn from the triradius (A) to the center of the core (B). All the finger ridges that cross or touch this A–B line are counted. The total ridge count (TRC) is the sum of all the single finger ridge counts of an individual. Three main digital pattern types are distinguished (Holt, 1968): arches, loops (ulnar and radial) and whorls, depending on the number of triradii (points where three lines meet). On average, women tend to have a higher frequency of arches, fewer radial loops and usually fewer whorls than men.

replicate the findings of two studies (Kimura and Carson, 1995; Sanders et al., 1995), which showed that L > individuals, irrespective of their genetic sex or sexual orientation, performed better than R > on female favoring tasks and, that R > performed better than L > individuals on male favoring tasks.

2. Method

2.1. Sample

Our sample included 184 male-to-female transsexuals (MFs) and 110 female-to-male transsexuals (FMs), all diagnosed as such by psychologists and psychiatrists from either the Free University Hospital gender team in Amsterdam or the Department of Child and Adolescent Psychiatry of the Utrecht University Hospital. They had either undergone sex reassignment surgery or were eligible for sex reassignment. All subjects participated voluntarily in our research. All procedures were carried out with the adequate understanding and written informed consent of the subjects. The study was approved by the institutional ethical review board. In this study 164 female controls (FCs) and 158 male controls (MCs) participated; all subjects were non-patients and took part in different research projects in the department. The female control group consisted of 87 adult women and 77 girls (age range: 8–9 years), whereas the male control group consisted of 88 adult males and 70 boys (age range 8–9 years). The adult control subjects were contacted in large supermarkets in Amsterdam and Utrecht and asked to participate in this study. All children were participating as control subjects in research projects of the department of Child and Adolescent Psychiatry. All controls, adults and children, were considered to be a representative cross-section of the normal population. As finger ridge counts remain stable over life, we included the data of the children, because these finger ridge data are suitable for analyses on finger ridge asymmetry and total ridge count. It is, however, difficult to establish their sexual orientation. We therefore left the children out of the analyses involving sexual orientation.

2.2. Procedure

Since the little fingers and thumbs are presumed to have the highest correlation with total ridge count (TRC) (Holt, 1968; Kimura and Carson, 1995), the prints of these fingers were recorded. After rolling the fingers on a ink patch as used by police departments, the ink fingers were rolled from nail-edge to nail-edge on a recording surface of a fingerprint form. Sex, gender identity, hand preference, sexual orientation and racial background (as far as two generations back) were recorded for each subject through a short interview. Whenever a subject was in doubt about his or her hand preference, we conducted the hand preference questionnaire (Van Strien, 1992). Subjects with a racial background of European origin were considered as Caucasians. The finger prints were analyzed according to the Henry System (Holt, 1968) by two well experienced professional dactylo-

scopists, who were unaware of the purpose of the study. They used a Henry magnifier glass, which has a red line that can be placed upon the finger print. The red line is orientated so as to connect the core with the triradius in order to count the intersecting ridges between these two marker points (see Fig. 1). Arches have no triradius nor a core, so this type of pattern has the count of zero. Loops can be either radial or ulnar and have a single count. Whenever a finger pattern was classified as a whorl, which has a radial and a ulnar count, we took the highest count as suggested by Holt (1968). In our study we defined TRC by adding the finger ridge count of the four fingers recorded.

A subgroup of transsexuals (60 MFs and 40 FMFs) and adult controls (35 MCs and 21 FCs) were tested on spatial ability and general intelligence. Data on these cognition tasks were collected by asking subjects who came in for recording their finger prints if they were willing to spend 30 min extra on the testing. Since the data collection of the finger prints and the cognitive tasks took place in the same test session, only afterwards were we able to divide these group for directional asymmetry. Because we hypothesized that MFs and female controls showed more leftward asymmetry than FMFs and male controls, we collected more cognitive data on the latter two groups in order to make the matching easier. The transsexuals were tested shortly before the start of their hormone treatment. These subjects ($n = 156$) were divided by directional asymmetry; leftward asymmetry ($L >$) was defined by a higher finger ridge count on the left hand, exceeding the right hand count by at least two. Rightward asymmetry ($R >$) was defined by a higher finger ridge count on the right hand, exceeding the left hand count by at least two (Hall and Kimura, 1994). Within this subgroup, 10 MFs, 9 FMFs, 4 FCs and 8 MCs showed $L >$ asymmetry. In order to compare these 31 $L >$ subjects with 31 $R >$ subjects on spatial ability, two groups were matched for sex of birth, gender identity, age, hand preference, sexual orientation and general intelligence, as measured by the verbal reasoning test (Luteijn and Van der Ploeg, 1983). In this task the subject had to identify the relationship common to two word-pairs. The relationship then had to be applied to a third word on the basis of which the respondent had to choose its pair from a list of five possibilities. This test contained 20 items, scores were based on correct answers. There was no time limit.

2.3. Instruments

It has been recognized that visuo-spatial ability exhibits large sex differences (Voyer et al., 1995). Therefore these matched $L >$ and $R >$ subgroups were compared on two spatial ability tasks:

2.3.1 Card Rotations, a two-dimensional rotated figures test (RF-2D; Ekstrom et al., 1976)

By comparing five alternatives with the example figure given, the subject had to decide which alternatives are identical by rotating them in a two-dimensional way. The subject had to identify the right answers by circling the letter above each figure. After practicing four example items and receiving feedback about the correct answers the subject had 3 min to finish the task (15 items). A total score was

Table 1

Mean total ridge counts on four fingers (thumbs and little fingers) and their standard deviations for Caucasian transsexuals and controls^a

Type	N	Mean TRC	SD
MFs	150	60.73	17.27
MCs	145	59.43	17.36
FMs	95	58.97	16.59
FCs	145	56.53	20.26

^a N, number of subjects; TRC, total ridge count; SD, standard deviation; MFs, male-to-female transsexuals; MCs, male controls; FMs, female-to-male transsexuals; FCs, female controls.

calculated by counting the points for all correct answers. The maximum score for the test was 75.

2.3.2 Rotated Figures three-dimensional test (RF-3D; Vandenberg and Kuse, 1978)

One subtest containing ten items with three-dimensional figures of the original test was administered. The subject had to compare one standard figure to four response figures and select the two correct rotated versions of the standard figure. After practicing three example items, 3 min were allowed to complete the test. The maximum score per item was two points, which was given only when both answers were correct; thus the maximum score was 20.

2.4. Statistics

Statistical Package for Social Science (SPSS) was used to analyze the data. The total sample includes all subjects ($n = 616$) with diverse racial backgrounds, hand preferences and sexual orientations. Depending on the analysis to be conducted, we selected only Caucasians, right-handed subjects or subjects of whom the sexual orientation was known. We conducted ANOVA to compare transsexual groups with their control groups for TRC. χ^2 -tests were used to compare percentages of L > and R > asymmetry within these four groups. Finally, R > and L > subjects matched for sex, gender identity, sexual orientation, hand preference, age and general intelligence were also analyzed for differences in cognitive functioning by ANOVA. The significance level was set at $P < .05$, while $P < .1$ was considered as a trend.

3. Results

3.1. Total ridge count

Because racial background might influence the total ridge count (TRC), only Caucasian subjects were compared on this variable: 34 MFs, 15 FMs, 13 MCs and 19 FCs were not Caucasian and therefore omitted for this particular analysis. Table

1 shows the mean TRCs as measured by counting the finger ridges on four fingers of the two Caucasian transsexual groups and the two Caucasian control groups. ANOVA's revealed that controls (males and females) did not differ from transsexuals (MFs and FMs) ($F[1,539] = 1.80$, $P = .19$); MFs did not differ significantly from MCs ($F[1,193] = .41$, ns); FMs did not differ from FCs ($F[1,244] = .96$, ns) and MCs did not differ from FCs ($F[1,294] = 1.74$, $P = .19$). However, comparison of genetic males (MFs and MCs together) with genetic females (FMs and FCs together) showed a trend towards a sex difference in TRC ($F[1,539] = 2.82$, $P < .1$).

3.2. Directional asymmetry

Because the hand preference might influence the direction of finger ridge asymmetry, only right-handed subjects were included for this analysis: 44 MFs, 27 FMs, 20 MCs and 10 FCs were either left-handed or without hand preference. The results of the right-handed subjects are summarized in Table 2. Among the sample of right-handed transsexuals, 20.0% of the MFs had a higher ridge count on the left hand than on the right ($L >$), while 25.3% of the FMs had a $L >$ asymmetry. In the right-handed control group 19.5% of the females and 21.0% of the males showed a $L >$ asymmetry. A χ^2 comparing these MFs to MCs for the direction of ridge asymmetry ($L >$ versus no $L >$ asymmetry (Lnot)) showed that this difference was not significant (χ^2 (1, $N = 278$) = .044, ns). Also, no difference in directional ridge asymmetry was found between these FMs and FCs (χ^2 (1, $N = 237$) = 1.08, ns), nor was a difference observed between genetic males (MFs and MCs together) and genetic females (FMs and FCs together; χ^2 (1, $N = 515$) = .058, ns).

3.3. Sexual orientation

Of the 140 right-handed MFs 87 were sexually orientated towards males (androphilic), 48 were either sexually orientated towards women (gynephilic, $n = 26$) or bisexual ($n = 22$) and of five MFs the sexual orientation was unknown. Of the 83 right-handed FMs 69 were sexually orientated towards females (gynephilic), seven were sexually orientated towards men (androphilic), six were bisexual and of one FM the sexual orientation was unknown. Of the 87 right-handed adult female

Table 2
Percentages of finger ridge asymmetry in right-handed transsexuals and controls^a

Type	<i>N</i>	% $L >$	% Lnot
MFs	140	20.0	80.0
MCs	138	21.0	79.0
FMs	83	25.3	74.7
FCs	154	19.5	80.5

^a *N*, number of subjects; $L >$, leftward asymmetry; Lnot, no leftward asymmetry; MFs, male-to-female transsexuals; MCs, male controls; FMs, female-to-male transsexuals; FCs, female controls.

Table 3

Mean raw scores on cognition tasks and the statistical differences between a rightward-asymmetry group (R>) and a leftward-asymmetry group (L>), each including a equal number of transsexuals and controls. The two groups were matched for sex, gender identity, sexual orientation, age, hand preference, and verbal reasoning^a

	R>			L>			<i>F</i> -value
	<i>N</i>	Mean	SD	<i>N</i>	Mean	SD	
Age	31	33.6	13.8	31	33.0	16.1	0.03
VR	31	13.8	2.5	31	13.2	2.3	1.25
RF-2D	31	45.6	8.7	31	47.7	12.7	0.54
RF-3D	31	7.6	4.5	31	7.9	4.4	0.10

^a R>, rightward asymmetry; L>, leftward asymmetry; *N*, number of subjects; SD, standard deviation; *F*-value, outcomes of separate ANOVA's; VR, verbal reasoning; RF-2D, rotated figures 2-dimensional; RF-3D, rotated figures 3-dimensional.

controls, only one was homosexual; of the 75 right-handed adult male controls two were homosexual.

Within the right-handed genetic adult male group, heterosexual MCs ($n = 73$), androphilic MFs ($n = 87$) and gynephilic and bisexual MFs ($n = 48$) were compared for directional asymmetry. L> asymmetry was found in 23.3% of the heterosexual MCs and in 24.1% of the androphilic MFs. Whereas the gynephilic and bisexual MFs had the lowest rate of L> (14.6%), this difference, which was not in the predicted direction, was not significant (χ^2 (1, $N = 208$) = 1.85, ns). Within the right-handed genetic female group, 17.4% of the heterosexual FCs ($n = 86$), 29.0% of the gynephilic FMs ($n = 69$) and 5.9% of the androphilic and bisexual FMs ($n = 13$) showed L> asymmetry. Although a trend was found for a difference in dermatoglyphic asymmetry between these groups, it was not in the predicted direction (χ^2 (1, $N = 172$) = 5.66, $P = .06$).

3.4. Spatial ability

Data from the rotated figures tests, which were analyzed by one way ANOVA are presented in Table 3. A comparison of genetic males ($n = 36$) with genetic females ($n = 26$) with age as a covariate, revealed that a sex difference occurred for three-dimensional rotated figures (RF-3D; $F[1,59] = 10.1$, $P = .002$), but not for two-dimensional rotated figures (RF-2D; $F[1,59] = .68$, ns). Finger ridge asymmetry was not related to spatial ability: neither to RF-2D ($F[1,60] = .54$, ns) nor to RF-3D ($F[1,60] = .10$, ns).

4. Discussion

Assuming that finger ridge counts are sexually dimorphic and knowing that physical and psychological characteristics that are sexually dimorphic could have

been influenced by prenatal exposure to sex hormones, the issue of finger ridge counts in transsexuals is an interesting one, because it has been found that transsexuals occupy a position in terms of verbal memory in between that of normal males and females (Cohen-Kettenis et al., 1998). Dermatoglyphic asymmetry has also been reported to be related to functional brain asymmetry. Therefore we studied the dermatoglyphics of transsexuals as compared to non-transsexuals.

In line with the sex difference normally found in non-transsexuals, we found a trend towards a small difference in total ridge count (TRC) between genetic males (MF and MCs together) and genetic females (FMs and FCs together). However, no differences in TRC were noted between male-to-female transsexuals (MFs) and male controls (MCs), on the one hand, or between female-to-male transsexuals (FMs) and female controls (FCs), on the other. Unfortunately, we failed to find a sex difference in TRC between MCs and FCs. However, our mean control data (145 males and 145 females) are well within the range of those found by others (see Table 4); but due to large standard deviations (found in all three studies), large groups are needed to find a sex difference.

We could not replicate the finding that more women (23.5%, $n = 98$) than men (13.0%, $n = 154$) showed a leftward asymmetry ($L >$) (Kimura and Carson, 1995). On the contrary, in our sample more men had a $L >$ pattern (21.0%, $n = 138$) than women (19.5%, $n = 154$), although the difference was not significant. We also observed no difference in directional asymmetry between MFs and MCs, or between FMs and FCs. Furthermore, the proportions of $L >$ individuals were similar in genetic males (20.5%, $n = 278$) and genetic females (21.5%, $n = 237$). Our findings are in line with another study using a large sample, which showed that more males (32.7%, $n = 254$) than females (28.3%, $n = 240$) had $L >$ asymmetry (Holt, 1968). In that study it was also estimated that the counts of the left and the right hand had a correlation of nearly 0.95 for each sex (Holt, 1968). Consequently, finger ridges on both hands are more symmetrical than asymmetrical.

In our study, the direction of dermatoglyphic asymmetry was not related to performance on spatial tasks. While, in line with a previous study (Slabbekoorn et al., 1999), genetic males were better than genetic females on three-dimensional visuo-spatial tasks, this finding could not be ascribed to an elevated score on this task in subjects with $R >$ asymmetry. Although two-dimensional visuo-spatial ability is known to exhibit a sex difference as well (Van Goozen et al., 1995), in this

Table 4
Mean total ridge count (TRC) and standard deviations (SD) of the thumbs and little fingers in males (m) and females (f)^a

Study	Number (m–f)	Males TRC (SD)	Females TRC (SD)
Holt (1968)	825–825	64.8 (23.1)	55.2 (24.6)
Kimura and Carson (1995)	154–96	65.6 (16.1)	59.2 (19.2)
Slabbekoorn et al. (1999)	145–145	59.4 (17.4)	56.5 (20.3)

^a We have extracted the data for four fingers (thumbs and little fingers) from the data that Holt (1968) has reported for ten fingers.

sample no difference was observed between genetic males and females, nor did we find a relation to finger ridge asymmetry.

We conclude that sex differences in our chosen dermatoglyphic characteristics, total ridge count and finger ridge asymmetry, if they exist at all, are very small and therefore not easily detectable. We found no evidence that transsexuals differ in dermatoglyphic count or asymmetry when compared to their genetic counterparts. This study, therefore, does not support a prenatal hormone influence on the development of transsexualism, insofar as such an influence might be reflected in total ridge count and finger ridge asymmetry. The fact that dermatoglyphics are formed in the third to fourth month after conception, leaves open the possibility that prenatal hormone influences earlier or later in fetal life, might play a role in the development of transsexualism.

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